REMARKS

Claims 1-28 were pending in this application.

Claims 12, 13, 16, 18 to 24, 26 and 28 have been amended.

Claims 1 to 11, 17, 25 and 27 have been cancelled.

Claims 29 to 54 have been added.

Claims 12 to 16, 18 to 24, 26 and 28 to 54 are pending in this application after the present amendment.

No new subject matter has been added.

Basis for amendments

The claims have been amended in view of the rejections raised in the office action. Furthermore, the amended claims now substantially reflect the claims of corresponding issued GB patents 2427186B and 2448432B.

Claim 12 has been amended to recite a first aspect of the invention in which a load motion measurement device is coupled to and provided on a load. This aspect of the invention finds basis in previously presented claims 12, 19 and 20. The load measurement device coupled to and provided to the load can also be deduced from page 21, lines 17-20 and page 28, lines 20-21. Claim 12 has further been amended to include a feature of original claim 13, namely that the winch or crane system is provided on a vessel.

Claim 16 has been amended to relate to a method according to the first aspect of the invention, thus also including coupling of a load motion measurement device to the load. In view of the amendments made to claim 12, claim 16 has also been amended to include the feature that the winch or crane system is provided on a vessel.

Furthermore, amended independent claim 12 now states that the control device controls the winch or crane system in response to said output to pay out or recover lift wire from a drum located on the vessel as required to stabilize the load and this feature finds basis on for example page 11, line 27 to page 12, line 5, page 16, lines 23-25 and also throughout the rest of the description and claims as filed.

The term "indicative of the movement of the load" has been included in independent claims 12 and 16 filed herewith for clarity purposes.

Claim 19 has been amended to more clearly recite the invention. Basis for the amendments can be found in previous claims 1, 5 and 17 presently cancelled, or in the description, for example on page 16, lines 23-25. In the aspect of the invention presented in presently amended claim 19, a load motion measurement device is no longer provided as opposed to previously presented claim 19. Since the features of previously presented claim 19 are now covered by claims 12 to 15 filed herewith, claim 20 has been amended to depend on independent claim 12, which comprises the load motion measurement device. Basis for this amendment can, for example, be found on page 10, lines 17-20.

The features of claims 21 and 24 can be related to both aspects of the invention covered by presently amended claims 12 and 19. Therefore, claims 21 and 24 have been amended to depend on claim 12 for the sake of clear arrangement and new claims 47 and 48, each depending on claim 19 and including the features of claims 21 and 24, have been added to the claim set.

The features of claims 22 and 23 originally depending on previous claim 19 are now included in the presently amended claim 19.

The method in claim 26 has been amended to focus the protection sought. Basis for the amendments can be found in either or both of the previous claims 19 and 26 or in the statements of invention in the description and for example on page 27, lines 19 to 31 or page 15, lines 23-25.

New claims 29 to 54 either relate to one of the independent claims 12, 16, 19 or 26 or to one of the claims dependent on the independent claims, and basis for these claims can be found in either or both of the previous claims or in the description.

It is respectfully submitted that no new matter has been added to the application.

Claim Rejections - 35 USC § 102

The Examiner rejected claims 1-28 under 35 USC § 102 (b) as being anticipated by U.S. Patent No. 6,216,789 to Lorsignol et al.

In response, the Examiner will note that the claims, particularly independent amended claims 12, 16, 19 and 26 filed herewith, have been substantially amended.

In particular, independent claim 12 has been amended to specifically recite that a load motion measurement device is coupled to and provided on the load. In response to an output of the load motion measurement device, the lift wire is paid out and recovered from a drum located on the vessel as required to stabilise the load.

Independent claim 19 now includes a lift wire resonance calculation means comprising a computational means into which an operator can input data concerning the elasticity characteristics of the lift wire, wherein the computational means takes data output from the lift wire distance measurement device and calculates the elasticity of the lift wire from the length of wire paid out, by reference to its elasticity characteristics. Again, in response to outputs from the various measurement devices mentioned in claim 19, the lift wire is paid out and recovered from a drum located on the vessel as required to stabilise the load.

U.S. Patent No. 6,216,789 to Lorsignol et al does not disclose a heave compensation apparatus with a load motion measurement device coupled to or even provided on the load. Instead, Lorsignol et al discloses a system that compensates for the effects of wave motion on floating installations (13) performing wireline logging. However, there is no load motion measurement device coupled to the load unlike amended claim 12 and, thus, the motion of the load (20) attached to the wire (15) is not (directly) measured. Furthermore, Lorsignol et al do not disclose a resonance calculation means as required in amended claim 19.

Moreover, a lift wire resonance calculation means according to claim 19 is not disclosed in any of the 17 documents cited by the Examiner.

In U.S. Patent No. 3,259,371 to Goepfert et al a weight (37) is resting on the floor (16) of the ocean (11) and a vertical movement of a floating marine platform, and not a movement of the weight (37) (load) itself, is measured.

U.S. Patent No. 3,648,858 to Barron et al only discloses a motion compensation hoist mechanism in which a load (E) is stabilized against swinging about a line with at least three lines connected to the load in spaced relation. No measurements of a motion of the load are carried out.

U.S. Patent No. 3,653,636 to Burrell only discloses a traveling block hoisting arrangement with a load cell (20) coupled to a kelly (21), the kelly (21) connecting the traveling block (13) and a drill string (11). However, the load cell (20) does not measure movement of the load/drill string and is not coupled to the load attached to a lift wire, but instead measures the weight of the load/drill string and is therefore more akin to a tension measuring device.

Although U.S. Patent No. 3,753,552 to Barron discloses a displacement control system for hoist apparatus in which measurements of the speed of motion of a load and changes in position of the load relative to a crane are conducted, the sensor is not provided on the load. Instead, the sensing means (SU) comprises a cable or line (25), a free end of which is connected (at 26) to a traveling block (12). However, this cable or line (25) differs from the cable or line (10) of the hoist means (H) hoisting the load (L) which is attached to the traveling block (12). The cable or line (25) of the sensing means (SU) passes over a suitable pulley (32) carried by the crane boom (B), and thence to a line position sensing unit (SU). Thus, the movement of the load (L) is only indirectly measured by the movement of the traveling block (12) and more particularly the line (25) which could for example stretch and give false readings.

U.S. Patent No. 3,946,559 to Stevenson discloses a heave compensation device which incorporates a passive load-supporting system which includes a cylinder (2) containing a piston (3) connected by a piston rod (4) to the load (5). Movement between the piston and cylinder and corresponding changes in pressure are considered and taken into account for heave compensation. Accordingly, movement of the load is not measured.

U.S. Patent No. 4,121,806 to Iato et al discloses an apparatus for compensation of variations in the distance between a load (109) suspended by a string of rods (111) from a vessel (101) and the sea floor. The vertical movement of a double action cylinder and piston assemblies (8) connected to the string of rods above the sea level and the velocity of the vessel are taken into account for the compensation. There is no measurement device coupled to or provided on the load for measuring motion of the load.

In U.S. Patent No. 4,236,695 to Morrison a system to maintain the tension in a rope (82) coupling a load to a winch is disclosed to compensate the relative motion between the load and the winch. The system also includes a hydraulic-operated ram (42A) for paying out and heaving in the rope (82), the tension in the rope (82) is sensed via hydraulic pressure in the hydraulic

system connected to the hydraulic-operated ram (42A). There is no measurement device coupled to the load.

U.S. Patent No. 4,544,137 to Johnson discloses a load lifting apparatus with wave motion compensation in which a traveling weight (16) is provided on the crane (10) and a direction of load movement is sensed according to the movement of the traveling weight. The traveling weight (16) is used to maintain the tension in the line (18). The means for sensing the upward or downward direction is a line direction sensing means (35) and is attached to the gantry pulley (13) and used to prevent improper operation of the traveling weight ratchet and pawl mechanism, for example a lifting of the load when the vessel falls. Thus, the motion measurement device is not provided on the load.

U.S. Patent No. 4,570,245 to Thigpen discloses a load cell and a tensiometer assembly (32) to sense a force or tension on a towing line (26) connecting a fixed shipboard and a marine seismic hydrophone streamer (12), but does not sense a motion of the streamer (12) itself. The paying out or retrieving of the line (26) is carried out in response to the sensed data for maintaining a substantially constant tension on the towing line (26).

Although U.S. Patent No. 5,140,927 to Tolefson discloses a motion measurement device (20) provided on a payload (25), it does not measure the motion of the payload (25) but instead measures the wave induced motion of the surface vessel (11) which is transmitted through the cable (16). Then, this motion is dampened or nullified before it is transmitted to the payload (25) by a movement of sheave carriages (33, 34) contained within housing (29), thereby paying out or taking up the cable (16). Since the sheave carriages (33, 34) are provided at the end of the cable (16) in the motion measurement device (20), the cable (16) is not paid out or recovered from a drum located on the vessel (11).

U.S. Patent No. 5,507,596 to Bostelman et al discloses a support system for supporting an underwater work platform (30). The length and tension of the cables (40) supporting the work platform (30) and being connected to the work platform (30) are measured. The position and angular orientation of the work platform (30) is automatically controlled. Further, the movement of the work platform is sensed. Thus, Bostelman et al does not even couple a motion measurement device to the load.

U.S. Patent No. 5,894,895 to Welsh discloses a heave compensator in which the movement of a traveling block (4), which provides a hook (H) for attachment of the load and a hook load sensor (12), is measured to compensate for vessel movement. However, the sensor (12) measures the load on the hook (H) and thus, the sensor (12) primarily measures the tension in the line (5) caused by movement induced into the travelling block (4) due to movements of the vessel (1) and not the movement of the load.

U.S. Patent No. 6,068,240 to Leveugle measures the tension of a cable (6) used to lift a load (11) with a load compensator (7) comprising pistons (15) and cylinders (17, 18) positioned on a truck (1) and a load cell (10) attached to the cable (6). A movement of the load itself is not detected.

U.S. Patent No. 6,817,422 to Jordan senses a movement of tensioners (20) located on a vessel wherein each tensioner (20) includes a tensioner piston travel indicator (27) indicating the travel of the piston in the tensioner (20). Further, a heave velocity experienced by the heaving vessel reacting to the wave motion can be detected. Measuring motion of the load is not even considered by Jordan by means of a measurement device coupled to the load.

In U.S. Patent No. 6,926,260 to De Groot et al only measurement of the vessel movement instead of measurement of the load movement is considered for controlling tension in a running or pipe string.

U.S. Patent No. 2005/0242332 to Ueki et al discloses a hoisting device (10) in which the movement of a pulley (20) (provided as wire hanging point at the tip of a boom (18) of the hoisting device) is measured. For example, an acceleration sensor (24) detects a vertical movement of the pulley (20). A wire speed sensor (26) senses a paying-out or rolling-up speed of the wire (14). So, Ueki et al do not at all disclose a load motion measurement device for measuring the motion of a load hoisted by the hoisting device (10).

Consequently, the applicant requests withdrawal of the rejection raised to the novelty of independent claims 12 and 19 and the corresponding method claims filed herewith.

Arguments Regarding Nonobviousness

The features of the present application solve the problem of how to compensate for heave in very deep water applications. The Examiner is referred to the Description of the Related Art of the present Patent application, for example to page 2, line 29 to page 3, line 16, and it is further pointed out that in many very deep water applications, steel wire lift cables cannot be used because they would snap under their own weight. In such circumstances lighter weight synthetic material such as nylon rope would need to be used. However, use of such a nylon rope in very deep water (i.e. 2000-3000 meters) with a heave compensator system would not be a viable solution, due to the very elastic nature of such a rope over such a long distance. Indeed, it is unlikely that a conventional heave compensation system would be able to cope with the elastic stretch of such a synthetic rope and the resonance that would be set up from such a rope and which would for example cause movement of a load heaved by the rope.

The present invention solves the problems by providing in a first aspect of the invention a heave compensation apparatus for a winch or crane system, wherein the winch or crane system is provided on a vessel, and the winch or crane system includes a lift wire for attachment to a load. The apparatus comprises a load motion measurement device coupled to and provided on the load for measuring the motion of the load, and a control device capable of receiving an output from the load motion measurement device indicative of the movement of the load. The control device controls the winch or crane system in response to said output to pay out or recover lift wire from a drum located on the vessel as required to stabilise the load.

There is no such load movement measurement device in any of the documents cited by the Examiner. The cited documents relate to conventional heave compensation systems and are not concerned with the resonance effects of the rope/lift wire in deeper water. In the first aspect of the present application, these resonance effects can be encountered with measuring the motion of the load directly at the load to effect compensation thereto. Since the compensation is conducted by the winch or crane system by paying out or recovering lift wire, the output of the load measurement device is directly sent to the control device, which is located on the vessel for controlling the winch or crane system.

In the vast majority of the documents cited by the Examiner, a sensor is not provided on the load but rather movement is measured (e.g. U.S. Patent Nos. 3,753,552; 4,544,137;

5,894,895) by a sensor which is for example coupled to a line or a travelling block. This way, measurement of the movement of the load is not provided but rather measurement of the movement of the upper end of the line or travelling block is measured. However, with such prior art arrangements, these measurements could not be equated with the movements of the load due to stretching effects of the line. For instance, in U.S. Patent No. 5,894,895, the load sensor at the hook suspending the load primarily measures the tension in the line due to movements which are induced to the hook by the movement of the vessel.

In these documents, it is an object of each of the disclosed systems to compensate the movement of the vessel or boat. The devices are thus not adequate to accurately measure the actual movement of the load which is important in deeper water due to the above mentioned resonance effect though, since they are not directly coupled to, and therefore do not directly measure the movement of, the load.

Furthermore, the cited documents do not even hint at providing a movement sensor on the load and this would not even be considered to be advantageous in view of these documents because it would add more cost to and/or be more time-consuming to provide each load to be moved with the winch or crane system with such a sensor when it is not even hinted at. Furthermore, none of the documents even consider to sense the movement of the load as precisely as is needed for compensating resonance effects.

On the other hand, when the sensor is provided on the load, as only disclosed in U.S. Patent No. 5,140,927, the compensation is executed directly at the load, since the device measures the movement of the vessel and at the same time provides means for compensating the movements of the vessel at the load itself and not on the vessel. Thus, it would not be desirable to provide measured data back to the boat or vessel of US 5,140,927 in order to pay out or recover lift wire from a drum which is located on the vessel.

According a second aspect of the invention, the above mentioned problem is solved with a heave compensation apparatus for a winch or crane system, in which the winch or crane system is provided on a vessel and includes a lift wire for attachment to a load. The apparatus comprises a vessel motion measurement device for measuring the motion of the vessel, a lift wire tension measuring device for measuring the tension in the lift wire, a lift wire distance measurement device which measures the length of lift wire that has been paid out, and a lift wire resonance

calculation means comprising a computational means into which an operator can input data concerning the elasticity characteristics of the lift wire, wherein the computational means takes data output from the lift wire distance measurement device and calculates the elasticity of the lift wire from the length of wire paid out, by reference to its elasticity characteristics. The apparatus further comprises a control device capable of receiving an output from the vessel motion measurement device, the lift wire tension measuring device, the lift wire distance measurement device and the lift wire resonance calculation means. The control device controls the winch or crane system, in response to the said outputs, to payout or recover lift wire from a drum located on the vessel as required to stabilize the load.

A resonance of the lift wire is not considered in these documents. In some of the documents, for example in U.S. Patent Nos. 4,570,245, 4,236,695, 5,507596 or 6,068,240, the tension in a cable or wire is measured. Variations in the tension on the cable can cause resonance effects but those cannot solely be deduced from the tension measurements because length and elasticity characteristics of the cable or lift wire have to be considered. Furthermore, none of the documents is concerned with the behaviour of a cable in deeper water which is when resonance effects particularly become a problem.

Accordingly, it is submitted that the present invention as defined in amended independent claims 12 and 19 involves an inventive step over the cited prior art.

CONCLUSION

It is respectfully submitted that all rejections or objections have been appropriately addressed and overcome by means of the arguments and amendments notes above. Reconsideration and withdrawal of the rejections are respectfully requested. It is also noted that the amendments made to the claims and application do not add any new matter.

Applicant respectfully requests that a timely notice of Allowance be issued in this case.

If the Examiner believes that direct communication with the Applicant's attorney would advance the prosecution of this application, the Examiner is invited to telephone the undersigned at the number listed below.

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